Application note for ATT7022B

Application note for ATT7022B ····· 1
Ⅰ **Hardware Circuit Design** ····· 2
Analog Input ····· 2
Electrical energy pulse output circuit ····· 4
Power Circuit ····· 6
Interface with the monolithic integrated circuit ····· 7
Judges the chip to work normally or not ····· 8
Ⅱ **Electromagnetic Compatibility Design** ····· 9
PCB Wiring explanation ····· 9
Ⅲ **Software Design** ····· 13
SPI 時序 ····· 13
Communication ····· 13
Measure the parameter ····· 16
The meter calibration referance ····· 21
Ⅳ **Software dial gauge formula demonstration** ····· 25
Software dial gauge application example: . ····· 26

This application note introduces the reference design method using ATT7022B to make a multi-functional electrical energy meter. Before reading this note, reading ATT7022B user manual thoroughly is suggested.

ATT7022B is a high-precision and multi-functional prevent fault fundamental and harmonic 3-phase electronic energy measuring chip. It incorporates 7 second-order sigma-delta ADCs. Among them, 3 are used for three-phase voltage sampling, 3 are used for three-phase current sampling, the last ADC is used for other guards-against in the zero curve electric current steals the electrical parameter the sampling, the output sampling material and the effective value. It is extremely convenient to use. This chip is suitable for three-phase three-wire and the three-phase four-wire applications.

This chip also integrated the reference voltage electric circuit as well as a digital signal processing electric circuit which can measure every electrical parameters including fundamental wave, harmonic wave, and the full wave (fundamental wave + harmonic, hereafter refers to as full wave). This chip can do active power/energy, reactive power/energy and apparent power measurement, as well as frequency measurement, all phase current, effective voltage value, power factor, phase angle parameters, and provides two kinds of apparent electrical energies (PQS, RMS), satisfies the three-phase multi-purpose electrical energy table as well as the fundamental and harmonic wave electrical energy meter demand fully.

The ATT7022B internal voltage monitoring electric circuit can guarantee the system works correctly even when the power is on or off. The ATT7022B provides a SPI interface, which facilitates transmission of the measurement and calibration parameters with exterior MCUs. It supports the full-range gain, the phase compensation, namely pure software calibration. Active and reactive electrical energy pulse outputs CF1, CF2, can be sent to a standard for error correction. And CF3, CF4 output active/reactive energy pulse for fundamental wave/harmonic wave, or RMS, PQS apparent electrical energy pulse.

版权归钜泉光电科技（上海）有限公司所有

Ⅰ Hardware Circuit Design

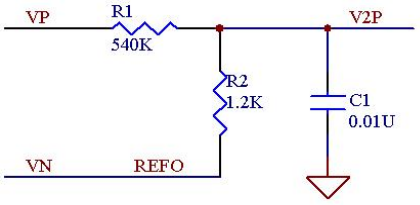
The ATT7022B is 44-pin QFP package. Peripheral hardware circuit mainly includes power supply, analog voltage and current input, pulse output and SPI interface, etc.

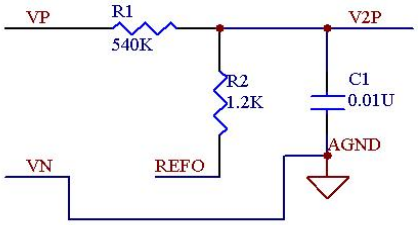
Analog Input

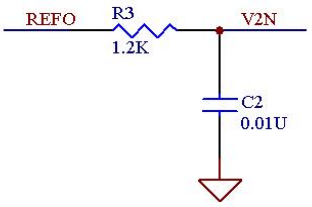
ATT7022B integrated 7 16-bit ADCs internally. The effective electric current is in the range from 2mV to 1V, with a linear error less than 0.5%. The effective voltage value is in the range from 10mV to 1V, with a linear error less than 0.5%. If the voltage value is in the range from 0.2V to 0.6V (amplified voltage value, suggested voltage sampling signal is 0.1V, choose the voltage channel amplification ratio to be 4), the electric current value is in the range from 2mV to 1V, the electrical energy linear error is smaller than 0.1%.

Each ADC uses pin VxP and VxN as AC input, and bias VxP, VxN to be about 2.4V DC voltage. This biased voltage can be obtained from the reference voltage output REFOUT of the chip, as well as from external reference voltage.

The sampling voltage input of three-phase-meter measuring chip can be obtained by selecting resistance divider method (e.g. Figure 1 and Figure 2) or the voltage transformer method (e.g. Figure 3), or converting voltage into current first, then passing through the current transformer, and transforming the electric current to voltage (e.g. Figure 4). The latter two ways uses mutual inductor, isolating the chip and the electrical network, thus obtain good anti-interference performance. Figure 1 connects zero curve VN and the chip reference voltage output REFO, this will conveniently add AC sampling signal up to the 2.4V DC bias. Figure 2 connects the zero curve and the chip's ground, this is suitable in application when the power supply is obtained from self-coupling transformer.







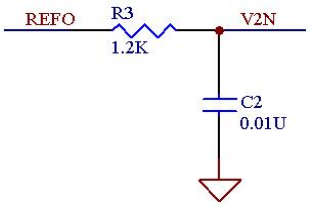


Figure 1 Uses the resistance divider to input voltage sampling (zero curve connected to reference output).
Figure 2 Uses the resistance divider to input voltage sampling (zero curve is connected to ground)

版权归钜泉光电科技（上海）有限公司所有

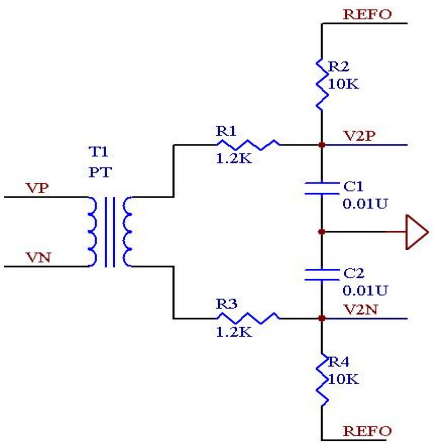


Figure3 Input voltage sampling using the voltage transformer

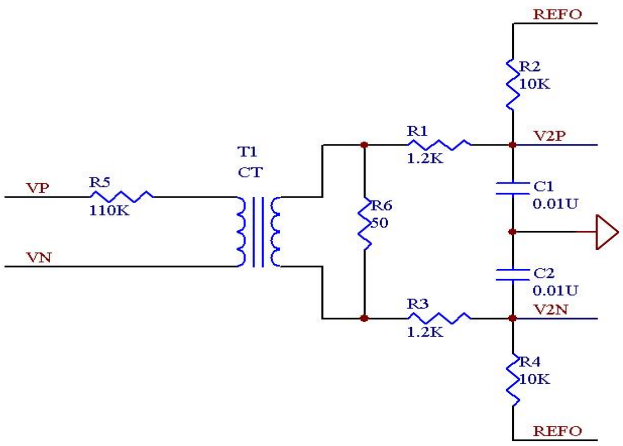


Figure4 Input voltage sampling using the current transformer

In Figure 1, Figure 2, VP and VN are the electrical network voltage, in these figures, all parameters are designed for 220V reference power supply. In Figure 3, PT transform the electrical network voltage (for example 220V) to the sampling voltage. In Figure 4, CT is 1:1 converter (for example, 2mA to 2mA).

The electric current sampling is obtained through the current transformer, there are several following wiring way.

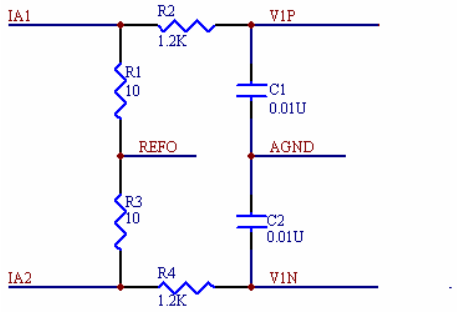


Figure 5 electric current sampling differential input

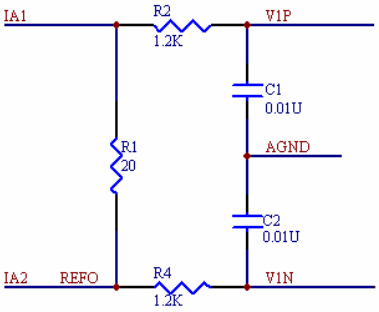


Figure 6 electric current sampling single-ended input

In Figure 5 and Figure 6, IA1 and IA2 are the second-order measuring signals. The 7-th channel ADC input design can refererence to this kind of network connection. When designing sampling input signals, please noth that:

1、Regardless of any input design method, the direct-current bias voltage for input pin VxP and VxN is about 2.45V. The bias voltage can be obtained by chip's 11-th pin REFOUT, otherwise the chip cannot measure accurately.

2、In order to guarantee the measuring accuracy, the 2 filtering capacitors outside the chip's 5th pin can't be omitted, and should be placed as close as possible to pin 5 and far away from other signals, the wiring between pin 5 and these 2 capacitor should be wide and short. These ground lines of these 2 filtering capacitors and the sampling signal should be connected as close as possible.

3、The resistor 1.2K and capacitor 0.01uF at VxP and VxN input circuit constitute the anti-aliasing filter, its structure and the component parameters need to be symmetric, and uses good temperature performance components, thus the electric instrument can obtain good temperature characteristic.

4、When any phase current and voltage are at reverse direction, chip pin 40 REVP outputs the high level, according to this, the wiring interconnection is correct or not can be known.

版权归钜泉光电科技（上海）有限公司所有

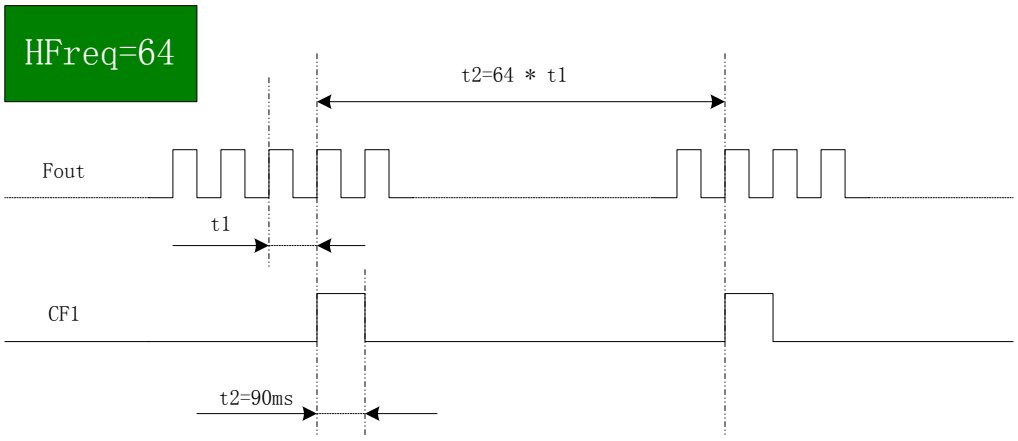
5、The chip input pin SEL is connected to the high level is used for three-phase four-wire configuration, while being connected to the low level is used for three-phase three -wire configuration.

6、The three-phase three-wire electric meter uses two method to do measurement. B-phase can't be used for electrical energy measurement, in the wiring substitute VN in three-phase four-wire case with VB. The voltage sampling inputs V4P and V4N, the electric current sampling inputs V3P and V3N can be input the independent signals, and their voltages, currents, power, and power factors, can be read from the B-phase corresponding registers.

Electrical energy pulse output circuit

Below is the active energy pulse signal generation process diagram:

The voltage and current signals after transformation are multiplied in DSP, then the transient-state power is obtained, after integrating over time, they become the electrical energy signals. According to the energy accumulation patterns, do absolute-value adding or the algebraic value adding operation for the three-phase electrical energy, and the result is transformed to the frequency signal, then carries on the frequency division according to the user hypothesis frequency division coefficient, obtains the electrical energy pulse output signal which can be used for calibration.



The reactive electrical energy pulse signal is the idle work transition condition power which in DSP obtains, becomes the idle work electrical energy signal after the time integral, again produces the idle work electrical energy pulse signal, the fundamental wave, the overtone actives with the idle work also is same, they all need to gather the energy accumulation pattern according to the hypothesis to do the three-phase electrical energy absolute value adding together or the algebraic value adding together operation, and the result transformation is the frequency code, then carries on the frequency division according to the user hypothesis frequency division coefficient, obtains available in the dial gauge electrical energy pulse output signal.The pulse width and the cyclical part production all is same, its production process overall diagram is as

版权归钜泉光电科技（上海）有限公司所有

follows:

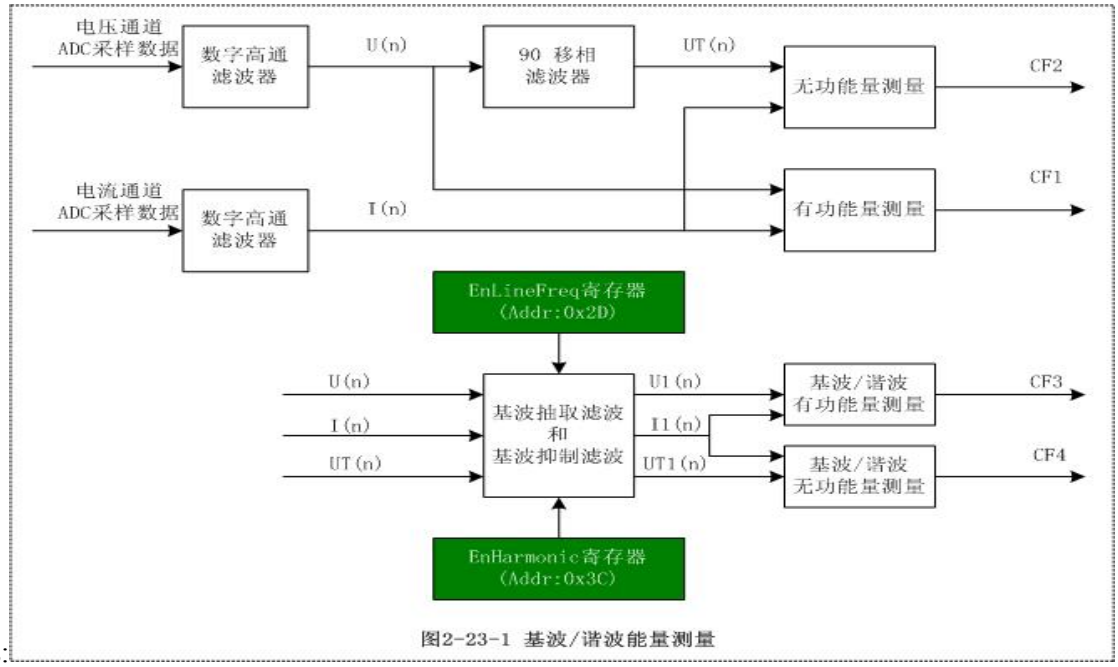
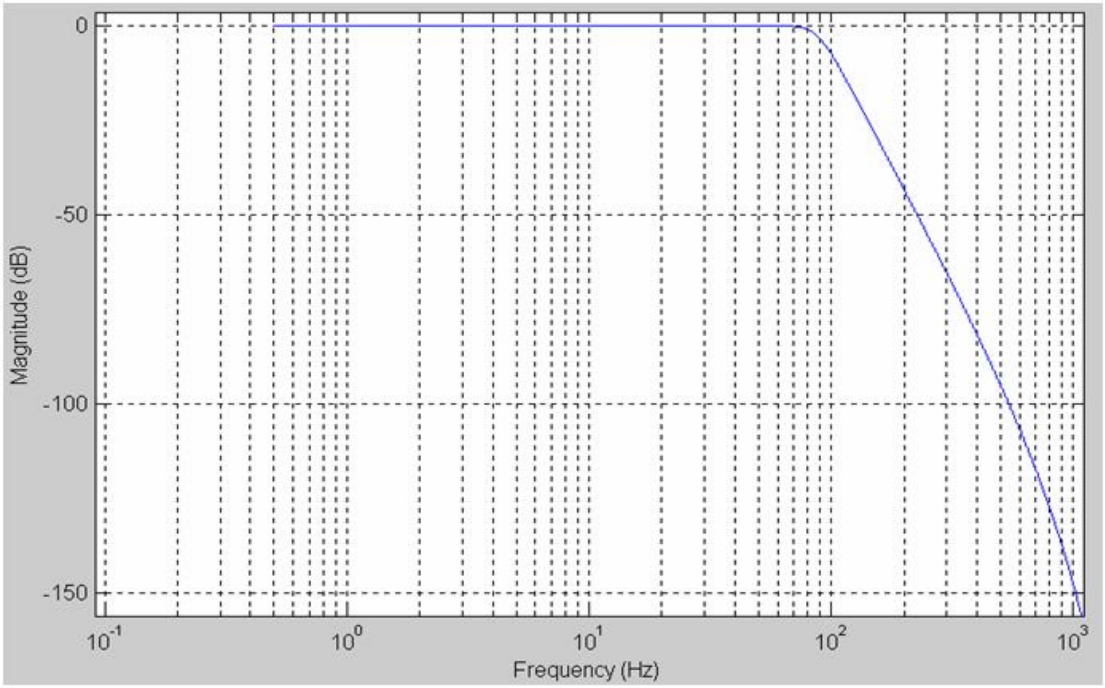


图2-23-1 基波/谐波能量测量

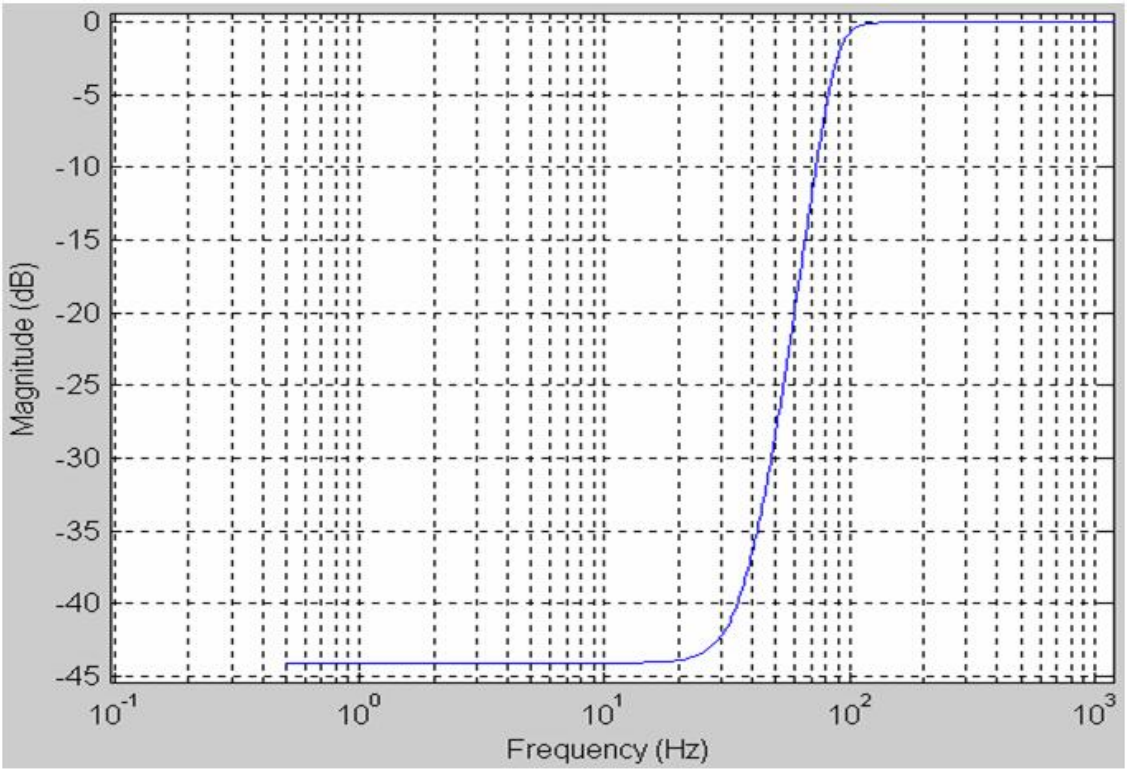
Is obvious by on chart, through two registers (0x2D and 0x3C) the establishment, may clear the fundamental wave or the overtone electrical energy measurement function.The fundamental wave survey enables control register EnLineFreq=0x007812, when the fundamental wave survey and the overtone survey cuts the choice register EnHarmonic≠0x0055AA, the choice fundamental wave table pattern, this time CF3/CF4 separately outputs the fundamental wave to active the pulse and the fundamental wave idle work pulse; When EnLineFreq=0x007812, EnHarmonic=0x0055AA, the choice overtone table pattern, this time CF3/CF4 separately outputs the overtone to active the pulse and the overtone idle work pulse.



Explanation: The fundamental wave extraction filter to are higher than 3 time (150Hz)

版权归钜泉光电科技（上海）有限公司所有

above overtone signals to carry on the weaken,



Explanation: The fundamental wave suppression filter carries on the weaken to the fundamental wave signal, only retains the harmonic components, the fundamental wave attenuation rate above - 30dB

When designing the electrical energy pulse output, you should pay attention to following several points:

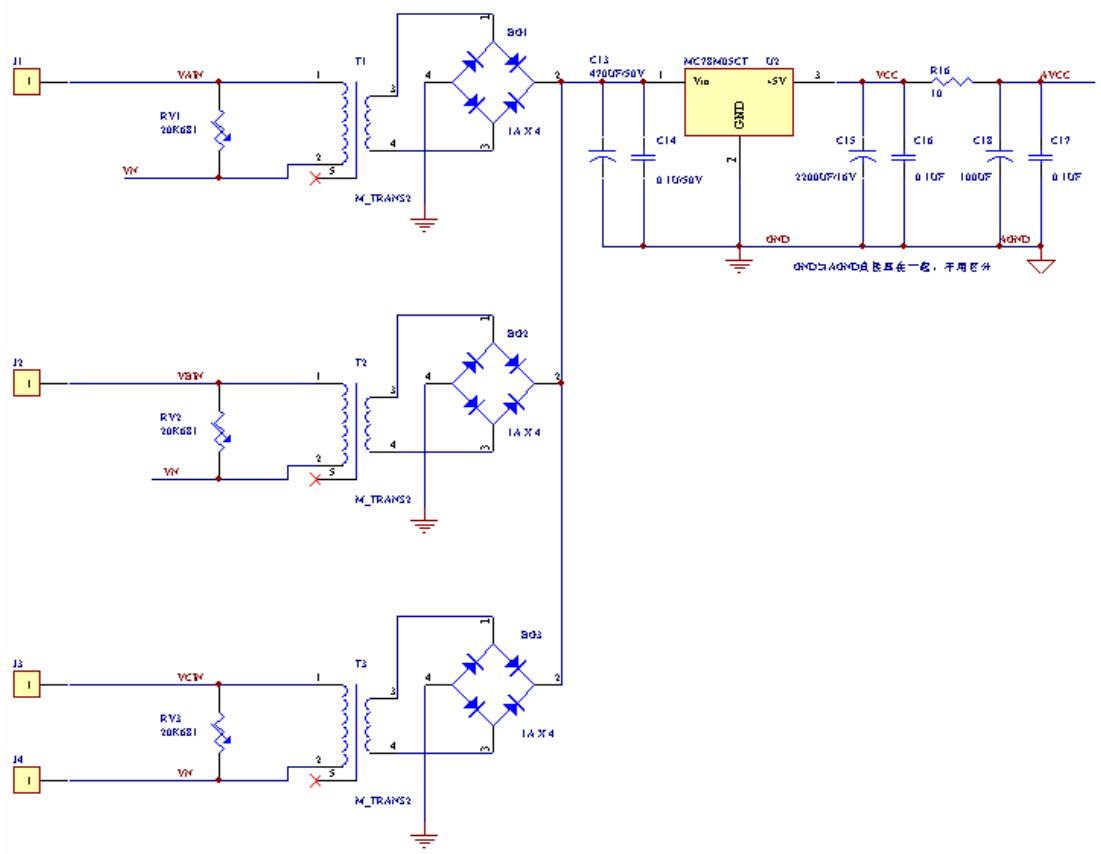
1、Choose appropriate energy accumulation method: three-phase electrical energy can be accumulated by algebra or by absolute value. After the ATT7022B is reset, the energy accumulation method is default to be the absolute value accumulation for the three-phase four-wire configuration (SEL is connected to the high level or floats), while the energy accumulation method is default to be the algebra value accumulation for the three-phase three-wire configuration (SEL is connected to the low level). Through writing calibration register 0x2A, the energy accumulation way can be changed.

2、The serial resistors at the electrical energy pulse outputs, CF1, CF2, CF3, CF4, should be close to chip pins, if the lead wire is long, the decoupling capacitor can be placed at the pulse output pin, thus obtain good electromagnetism compatibility.

Power Circuit

The next chart is a three-phase power supply schematic diagram:

版权归钜泉光电科技（上海）有限公司所有



The power circuit design is important to the electric instrument performance, in order to guarantee the good electromagnetism compatibility, please note following several points:

1、Power supply voltage VCC, AVCC should be in 5V±5%.

2、Suggest a 2200uF filtering capacitor at 7805 output termination.

3、GND and AGND are digital and analog power source reference points, for PCB wiring connect them with big-area ground lines, do not separate or differentiate GND and AGND, do not connect inductor, resistor, or magnetic bead, etc., between GND and AGND.

4、The big-area ground lines don't be stretched in front of the rectifier cell. Do not place ground lines under the fixed resistance used for voltage sampling, achieves strong and weak electricity separation.

5、Decoupling resistor R16 and capacitor C17, C18 should approach to the IC analog part to guarantee good filtering effect.

6、Use the resistor network voltage-divider sampling circuit, VN is connected to the internal circuit through the varistor.

Interface with the monolithic integrated circuit

There are 6 connecting wires between ATT7022B and the monolithic integrated circuit. 4 wires are SPI signals: CS, SCLK, DIN, DOUT, 1 is the ATT7022B reset wire, the last 1 is the handshaking wire SIG, pay attention to following items:

1、ATT7022B uses the 5V power supply, when connecting with 3V-power-source monolithic integrated chip, voltage level transformation is a must.

2、The SPI communication wiring should be as short as possible and be shielded by the ground lines, otherwise, the SPI transmission signals might get interference. You can also connect a 10Ω resistance

版权归钜泉光电科技（上海）有限公司所有

near chip SPI end and add a decoupling capacitor in the signal input end, thus constitute a low-pass filter to eliminate high frequency interference. As long as the SPI communication speed is in normal situation, the decoupling capacitor can be chosen to be large enough to strengthen its anti-interference ability. Pay attention to the resistor and decoupling capacitor at CS, SCLK, DIN pins should be as close to the chip as possible, while for DOUT pin, these components should be as close to the monolithic integrated circuit as possible. Although ATT7022B has a very perfect verification method for SPI read-write operation, strengthening the anti-jamming ability is still very important.

3、The monolithic integrated circuit must monitor the SIG signals or their conditions. When the power is turned on or when ATT7022B is reset, exterior MCU must update the calibrating data through SPI pins to guarantee the measurement accuracy. The SIG signals are used to handshake with exterior MCU. Putting 0.01uF decoupling capacitors at SIG inputs of the monolithic integrated circuit can strengthen its anti-jamming ability. Of course you can check the bit 7 of the flag condition register (address: 0x2C) is set or not to make sure the calibrating data need update or not.

4、After the power is turned on or ATT7022B is reset, in order to keep synchronous between the monolithic integrated circuit and ATT7022B, the ATT7022B RESET signal is controlled only by the monolithic integrated circuit. The reset process is that: the RESET signal keeps at low level more than 20uS, the chip is reset, then SIG outputs the high level, then the monolithic integrated circuit pulls the RESET signal to high level. After about 500uS, ATT7022B completes the initialization, SIG outputs the low level signal, hereafter normal SPI operation can carry on. Connecting a 0.1uF decoupling capacitor at the ATT7022B RESET port to improve its anti-jamming ability.

Judges the chip to work normally or not

After turning on ATT7022B system, how to judge the chip to work normally or not? Please do the inspection from following guidelines:

1、Check every voltage pin is normal or not. After turning on power, VCC, AVCC should be connected to 5V voltage, while VDD (chip pin 33 and pin 39) is generated internally with 3V normally. VDD pin is used for connecting off-chip filtering capacitance, do not use it for other purpose, nor to connect to any power supply. The 5th pin is a reference voltage for internal use. The 11th pin is the reference voltage output, providing a DC offset bias to external input circuit. The normal working voltage of these two pins arrives between 2.3V to 2.7V, which is produced by internal circuit.

2、Because the ATT7022B measurement part uses digital filter structures, therefore in order to guarantee the measuring precision, it is suggested to select a 24.576MHz crystal oscillator to inspect if the crystal vibrates normally, frequency and vibration range conforms to the requirement.

3、RESET Signal (1st pin) is connected to power VCC in normal operation. If connected to GND, the chip is always in the reset state.

4、**SIG** is LOW after the chip is reset, it becomes HIGH after the chip accepts one WRITE for about 5 uS from the monolithic integrated circuit.

After checking the above items and all signals work normally, it shows the chip is in normal operation, otherwise, you should inspect the wiring connection is correct or not, or if there is any short-circuit, faulty soldered joint, etc.

版权归钜泉光电科技（上海）有限公司所有

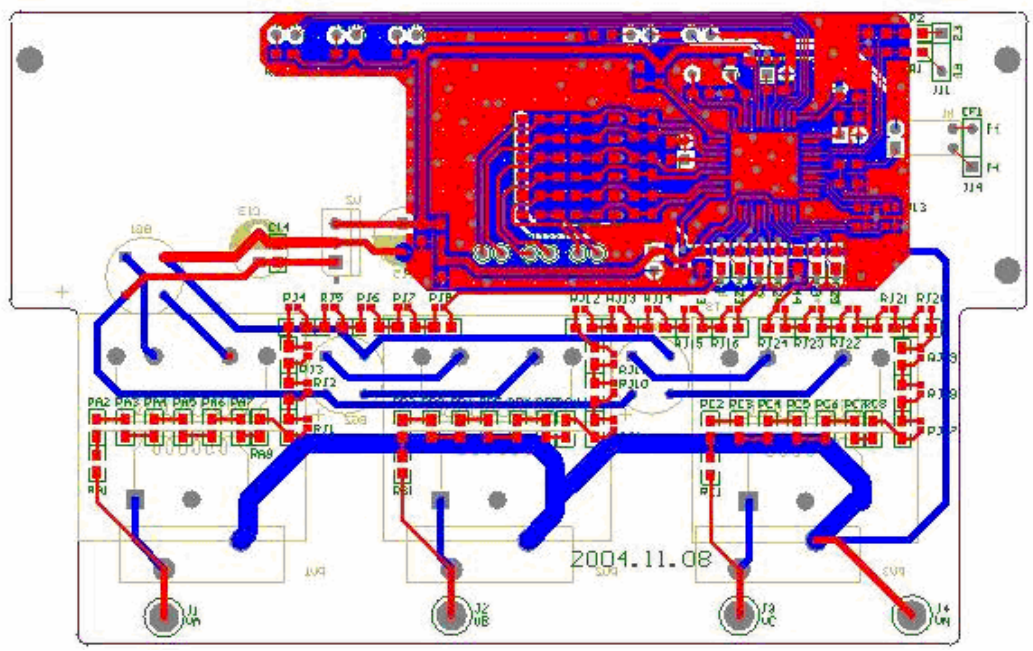
Ⅱ Electromagnetic Compatibility Design

Electromagnetic compatibility importantly guarantees the reliability of an electric meter. For ATT7022B application, there are several suggestions for everybody reference.

PCB Wiring explanation

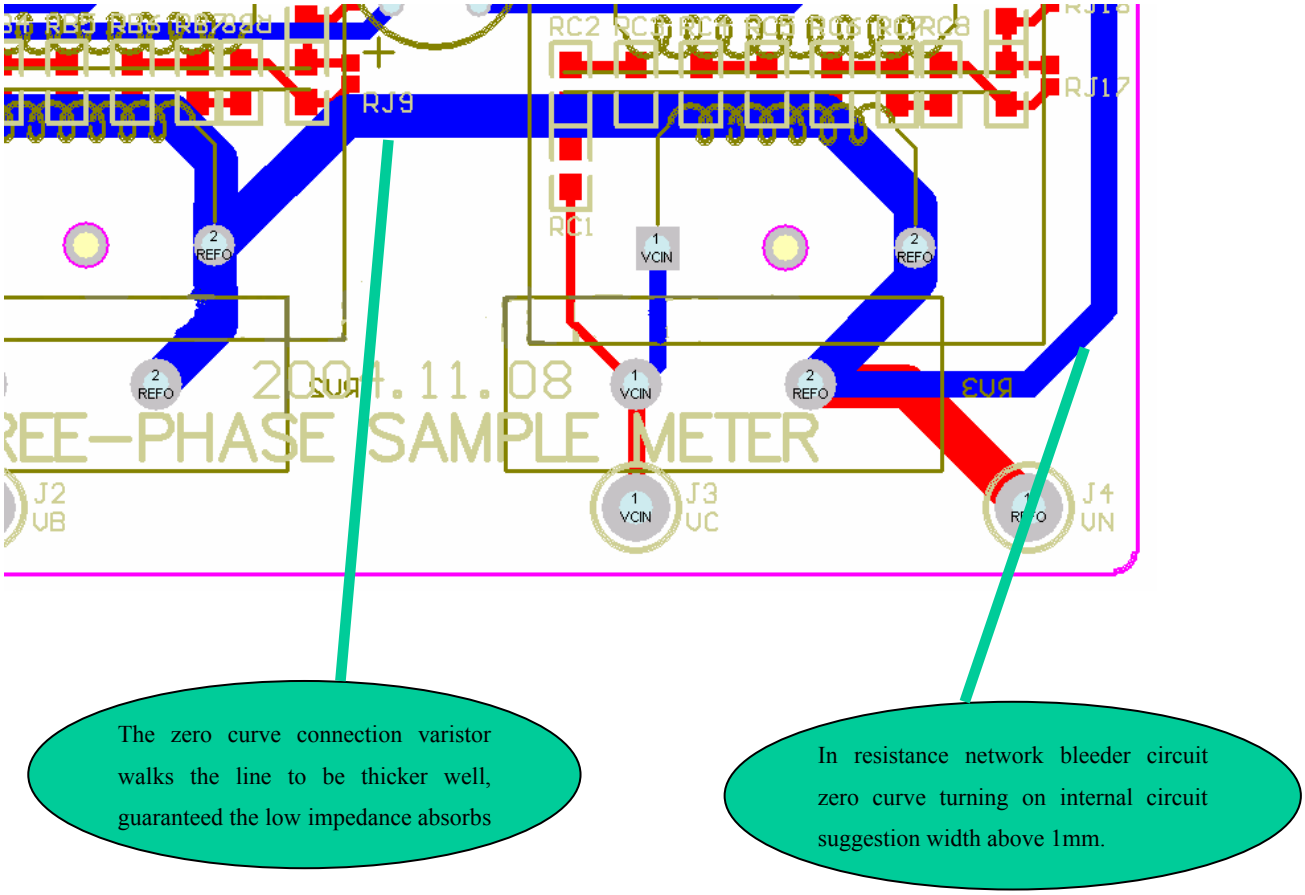
After the correct schematic diagram design is completed, it is transformed into a printed-board circuit diagram. A good PCB design can get good electromagnetic compatibility performance. The next picture is a reference PCB design using ATT7030A.

1、 Pay attention first to separate strong and weak electrical signals.

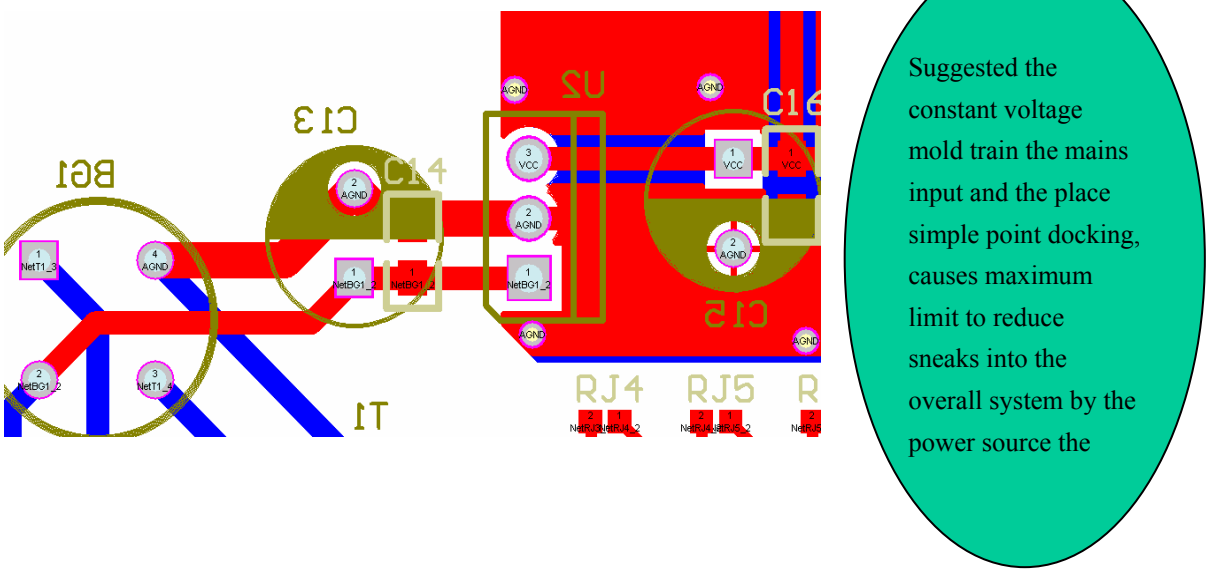


2、The power line and ground line should be first connected to varistors and then to internal circuits, so that to protect internal components. The ground line is a very important disturbant conduction route for EFT test, pay special attention to ground line wiring. After varistors, the wiring path to power transformer and connection to common sampling end should separate very clearly, do not mix up, this is very important.

版权归钜泉光电科技（上海）有限公司所有

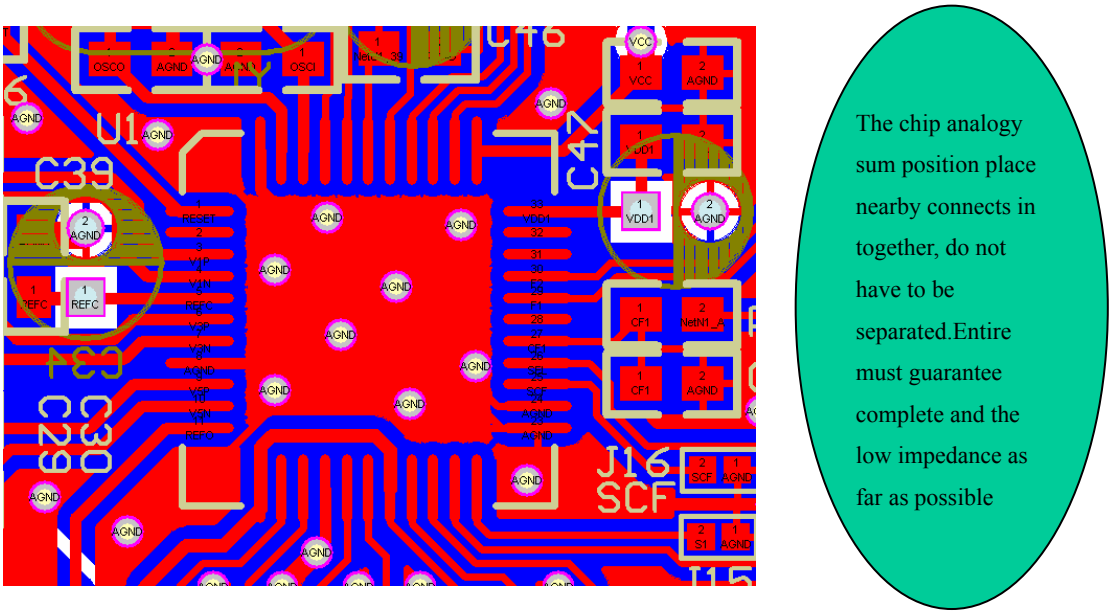


3、The grounding connection is vital to the electromagnetic compatibility performance, pays attention to the power ground and the signal ground junction point.

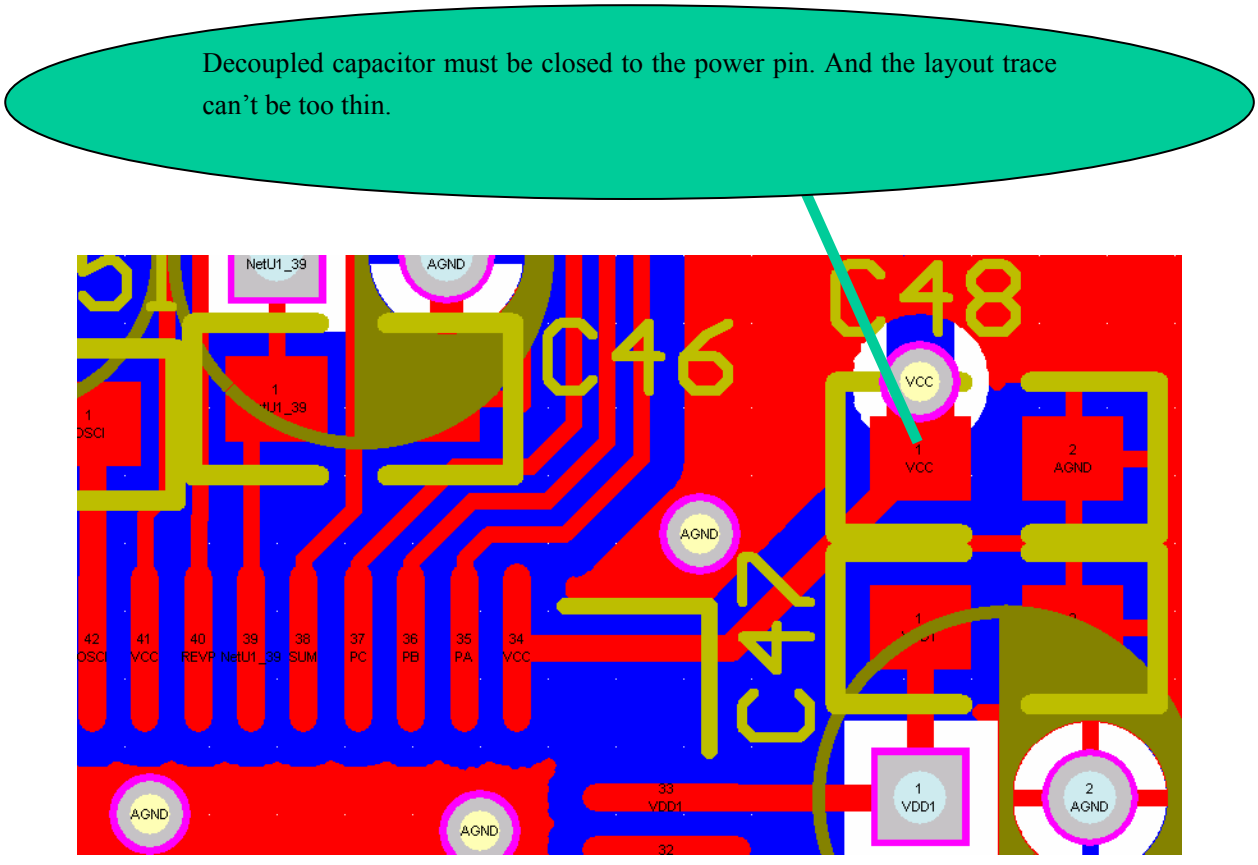


4、ATT7022B has many kinds of power sources VCC, AVCC. Pay attention that the analog and digital ground should connect together when they are close, don't need to differentiate the type. So the resistance, inductance, and parasitic capitance on the ground line can be reduced dramatically.

版权归钜泉光电科技（上海）有限公司所有

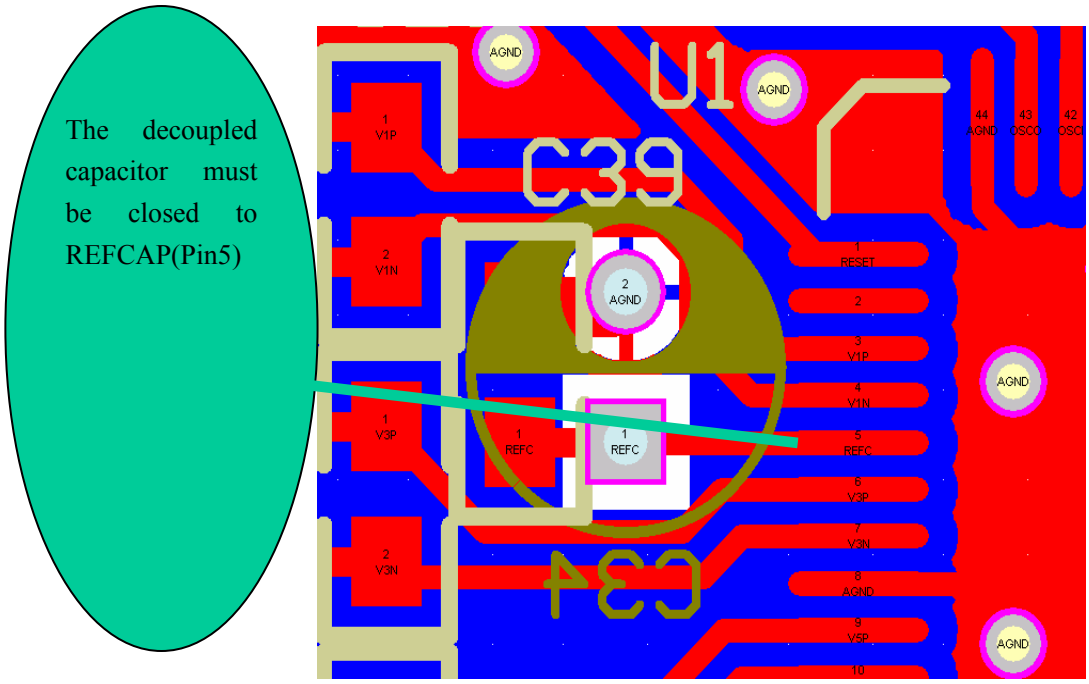

The chip analogy sum position place nearby connects in together, do not have to be separated.Entire must guarantee complete and the low impedance as far as possible

5、Pay attention on the position of the decoupled capacitor which on chip power pin.

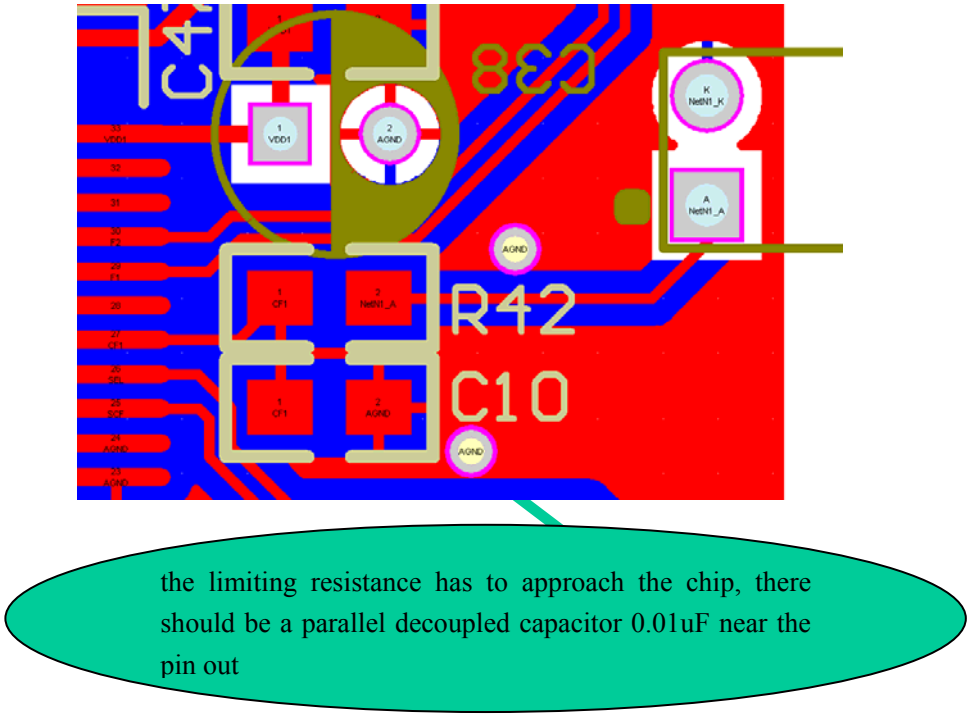


6、REFCAP is reference voltage pin in analog part of the chip, it will effect the exactness. The decoupled capacitor will enhance the stability of the reference voltage.

版权归钜泉光电科技（上海）有限公司所有

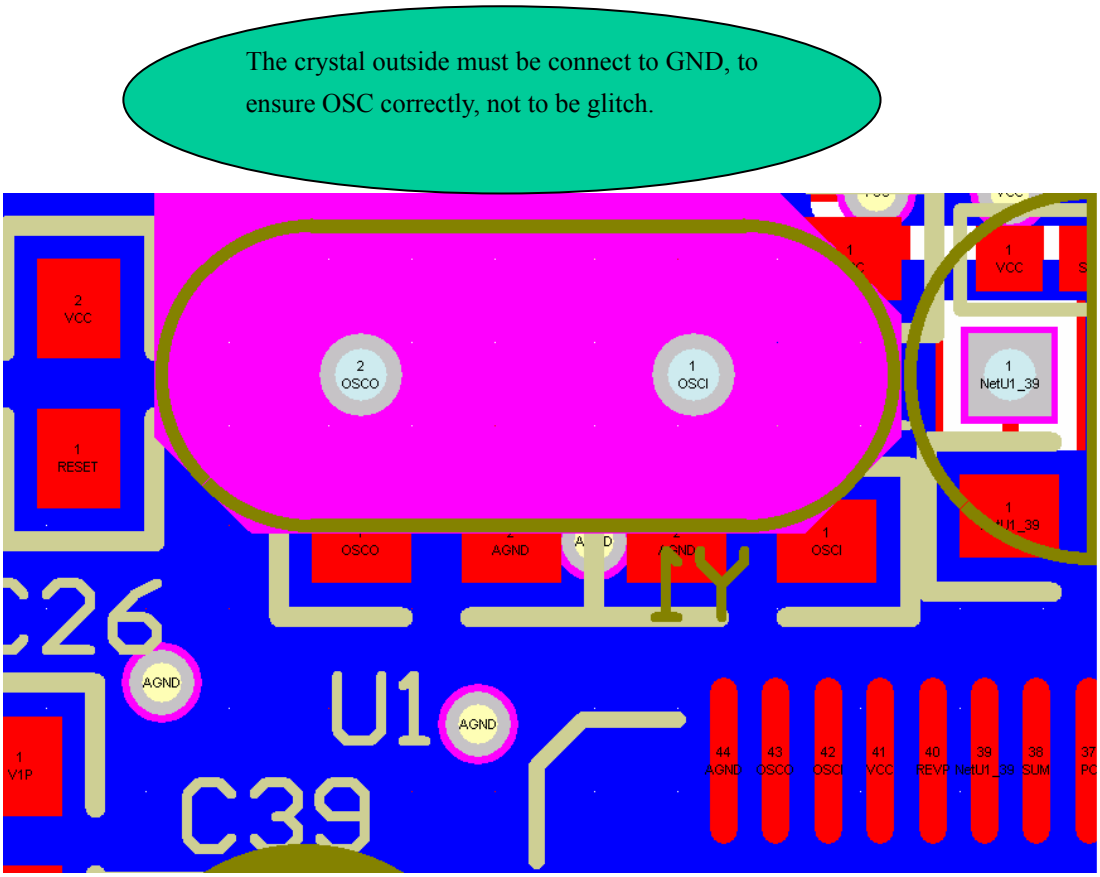


7、The pulse output trace is usually to be longer, the limiting resistance has to approach the chip.



8、Oscillator is a high frequency component, there must be copper around the clock trace, and other signal trace can't across the clock trace .

版权归钜泉光电科技（上海）有限公司所有



Ⅲ Software Design

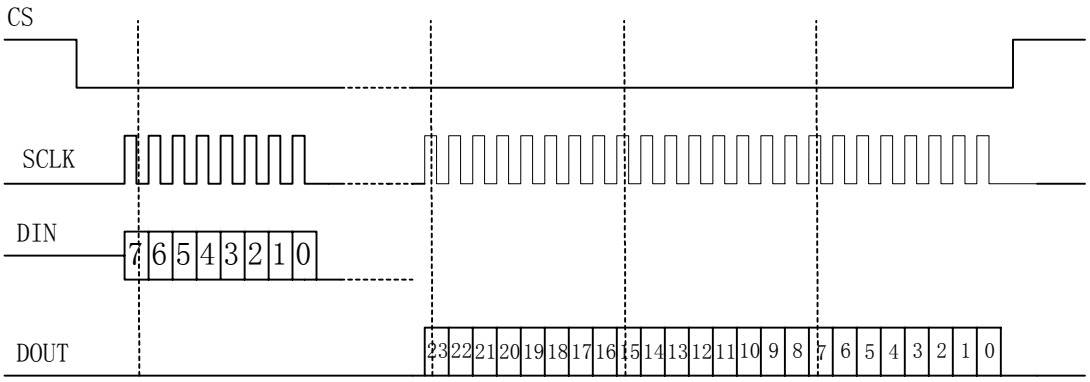
SPI時序

Communication

SPI communication form of ATT7022B is the same, 8 addresses, 24 materials, MSB is in the front,LSB in behind,read it write about register per piece there aren't CS the signals, in other words, SCLK is the low level when the communication begins, CS is from high to low, through 32 clock pulse SCLKs, CS is from low to high, finishes the reading or writing and operating of a register. ATT7022B decline in clock along on-line to fetch data that one-chip computer send from DIN, rise along from on-line to see datum off to the one-chip computer DOUT have.

The following is reading and operating time sequence :

版权归钜泉光电科技（上海）有限公司所有



After the one-chip computer sends 8 addresses, wait to read the materials from DOUT on-linly 3 microseconds later at least.

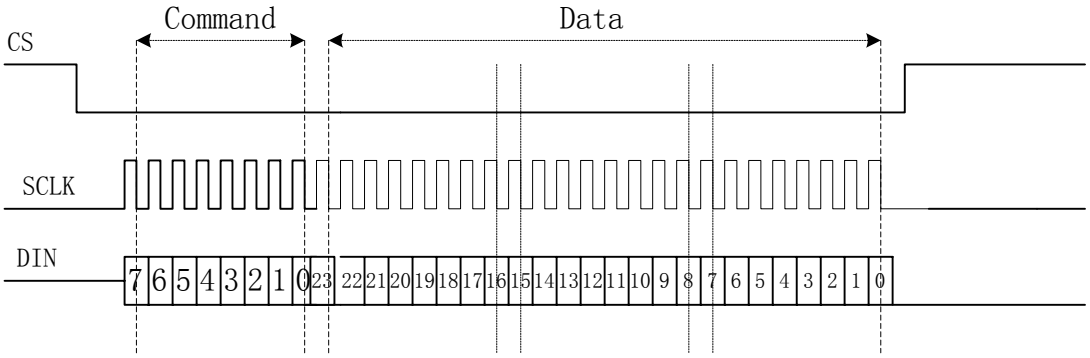
SPI reads time sequence：

```
ReadSpi(Com)
{
    ; Enable SPI
    CS=1;
    SCLK=0;
    CS=0;
    ; Send 8-bits Command to SPI
    for(n=7;n>=0;n--)
    {
        SCLK=1;
        DIN=Com.n;
        NOP
        NOP
        NOP
        SCLK=0;
    }
    ; waiting 3us
    delay(3);
    ; Read 24-bits Data From SPI
    for(n=23,Data=0;n>=0;n--)
    {
        SCLK=1;
        nop
        nop
        nop
        Data.n=DOUT;
        SCLK=0;
    }
    ; Disable SPI
```

版权归钜泉光电科技（上海）有限公司所有

```
    CS=1;
    ; Return Data From SPI
    return(Data);
}
```

The following is reading and operating time sequence :



SPI will write and operate and grasp several main points while reading:

1. It is draw high CS to want to finish to operate each time , it will operating drawing low to read/write next time.
2. Before the CS is drawing low, SCLK should be in the low level state.
3. While writing the order word or the address or the materials, high level in SCLK want materials entered to write ready, DIN decline in SCLK is that SCLK rise and release the data along DOUT while reading the data along adopting the materials into it.
4. The materials are put to the mouth on-linly, through several NOP, read and enter the one-chip computer or write into and measure the chip after the materials are steady.

SPI writes time sequence:

```
WriteSpi(Com,Data)
{
    ; Enable SPI
    CS=1;
    SCLK=0;
    CS=0;
    ; Send 8-bits Command to SPI
    for(n=7;n>=0;n--)
    {
        SCLK=1;
        DIN=Com.n;
        NOP
        NOP
        NOP
        SCLK=0;
    }
```

版权归钜泉光电科技（上海）有限公司所有

```
            ; Send 24-bits Data to SPI
            for(n=23,Data=0;n>=0;n--)
            {
                SCLK=1;
                DIN=Data.n;
                NOP
                NOP
                NOP
                SCLK=0;
            }
            ; Disable SPI
            CS=1;
}
```

Measuring the parameter and exporting it in the register, 0x2D , 0x2E, for the materials that SPI was written into of last time, 0x28 was last materials read, while writing the procedure that SPI reads and writes , use these registers to do than correctly, can improve the dependability of the communication . Propose sending order 0xC9 , materials 0x000001 after finishing SPI to write and operate in addition, close the writing and operating of the form register of SPI checking, prevent the checking form materials register from being written by mistake by SPI, if writing with operating SPI , send order 0xC9 , materials 0x000000, and then carry on the operation of writing of SPI. Last and ChkSum2 (0x5F) ATT7022B, it use for not for ATT7022B all checking of check-up , form of materialsesing and, it is upgraded 3 times that per second, read the value of check-up and register regularly, the check-up and value that are kept with the one-chip computer are compared , such as is it prove checking form materials , materials of register correct , such as is it prove checking form materials , materials of register interfere changing to vary to equal, need to hand over the checking again.

It is easy to read , write with and check the register , check-up and register , and SIG signal to use, can improve the anti-interference ability of the products from software design

Measure the parameter

All measurement value of ATT7022B can be read from measuring the parameter register, per second to do the data three times to upgrade(is 3.2K that the materials export the speed of upgrading that the seventh No. ADC of 0x3f sample), these parameters have:

Power:

Base wave , wave , active power of the whole wave , inactive power , apparent power in harmony , among them there is value of shutting looks of dividing every phase. The power is the quantity with symbol, all gains merit and the inactive power have directions, preserve in the form of mending and counting in the register, direction of the power that the high position express the most of the materials, express 0 it is to,express 1 backward. It is the algebraical sum of the power of every point of looks to shut the power of looks , utilize and shut the active power of the looks , direction of the inactive power, can make the measurement of power of four quadrants .

ATT7022B sets up the power direction register specially, collects every phase and gaining merit , power direction without work which shuts the looks among them , benefit user's use. The calculation of the power, reduced to dividing the looks parameter for original yard by the reading of the register (reading of namely the register is two carry figures, the high position is 1 o'clock

版权归钜泉光电科技（上海）有限公司所有

the most in reading, need the reading of the register to fetch the operation with 1 inside out. Reading most high position for o'clock such as 0,reading there is for yard not original itself) after divided by 2 ^ 8, to shut looks parameter whether register reading reduce for former yard divided by 2 ^ 6, the value calculated out should also be multiplied by coefficient 3200 / N (N is the pulse constant), after the ones that finish the power and gain and compensate are corrected, this is the real power. Have not adopted several to move the looks wave filter of the work measurement, has finished moving 90 degrees of signals of looks to deal with to the voltage signal, base on the premise that the signal one reacts and does not decay frequently , can move 90 degrees of processing lookses to the sampling signal of 30-1500Hz .

Power factor and photo corner:

Base wave , the wave in harmony , the whole wave divide into the looks , power factor of shutting looks and photo corner. Power factor and photo corner are all the value with symbol, preserve in the form of mending and counting in the register, the power factor or the direction of the photo corner that the high position express the most of the materials, its definition and inactive power direction are defined the samly, 0 expresses that, 1 is being expressed and shouldered . Reduce the factor register reading of the power as original yard divided by 2 ^ 23 receives the power because of number value, after the school form finishes the phase place to compensate, this is the real power of electric wire netting because of number value. The photo corner one it is for being original behind ¦Á since there is calculation reduce register reading,? =(¦Á / 2 ^ 23)*2*180 / π . In different quadrants, the angle shown needs to change as follows: , have work as active power as when being, actual angleΦ; When the active power is, there is no work in order to shoulder, the real angle is 360-Φ; For shoulder , have work as active power as when being, actual angle 180 ~ -Φ; When the active power is in order to shoulder , there is no work in order to shoulder, the real angle is 180 ~ +Φ.

Power factors and photo corner parameters do not need correcting .

Voltage contained angle:

ATT7022B provides the contained angle of the voltage of every point of looks, only the parameter of the whole wave, offer the contained angle that three register YUaUbs , YUaUc , YUbUc express AB/AC/BC voltage respectively. Need to measure the function of the photo corner of the voltage and open to examine to, read register value divided by 2 ^ 13, it is the measurement value. The contained angle parameter of the voltage does not need correcting , but only when the contained angle measurement of the voltage can control register EnUAngle to make =At the 0x003584, ATT7022B does not can measure photo corner measurement of the voltage, thus receive the contained angle parameter of the voltage; The voltage contained angle of ATT7022B is measured the function to close when acting as EnUAngle register other content not equaling 0x003584 s. When base wave, wave and electric energy in harmony measure the function and open, the voltage contained angle can't be opened to test the function for a long time.

RMS value:

ATT7022B offers the base wave , wave and virtual value of voltage of every point of looks and the voltage vector quantities of three phases and virtual value of the whole wave in harmony , and the electric current virtual value of the whole wave, the vector quantity of the three-phase current and virtual value. Read register value divided by 2 ^ 13, it is the measurement value. Can find out the gaining and compensating and gaining and compensating carrying on with the power separately of

版权归钜泉光电科技（上海）有限公司所有

virtual value while dealing with the procedure by ATT7022B signal, even if the electric energy error is regulated, virtual value still needs to correct one by one. 7 No. ADC usually is it measure Line zero electric current size to use for, virtual value its the same as calculation formula of other voltages electric current to calculate formulae, but the 7th No. ADC needs to be controlled and opened by bit0 of register GCtrlT7Adc, Bit0 =1 is opened, Bit0 =0 are closed .

Vector quantity sum of the three-phase current:

Offer ATT7022B vector quantity of three-phase current and virtual value export,can offer size , Line zero of electric current measuring with it at application , three-phase of Line four. In order to guarantee the precision of this vector quantity and calculation , propose that electric current value and sampled value after correcting are close, the correcting value is multiplied by a coefficient, get the measurement value in the one-chip computer. For example, under the electric current Ib condition of inputting, such as Ib being 1.5A, the value of A looks electric current register is 66A before correcting, the value of B looks electric current register is 63A, the value of C looks electric current register is 61A, do the electric current and correct A , B , C looks electric current value to 60A while correcting, in this way,let's do by vector quantity and when can guarantee there aren't materials calculated to participate in, thus guarantee the precision of the vector quantity sum of the three-phase current. After the electric current value after correcting of the one-chip computer is read, are multiplied by coefficient 1.5/60 =0.025, can be measuredding value 1.5A.

Measuring of voltage and electric current looks preface:

In the application of three-phase Line four , judge through the order of passing the zero point of measuring the voltage , electric current signal whether the looks preface of the voltage , electric current is normal. So long as the voltage of a phase is lost and pigeonholed, the voltage indicates against the looks preface that puts the location ; So long as there is a phase electric current too that is zero, the electric current indicates against the looks preface that puts the location . In the application of the three-phase the strategic hinterland of China, the looks preface of the voltage is judged through the size of the voltage contained angle, do not offer the judgement function of looks preface of the electric current at this moment. Notice electric current measurement , looks of preface is it can make controller their first to need , namely school form register 0x30 assignment 0x005678. When base wave, wave and electric energy in harmony measure the function and open, the electric current can't be opened for a long time while measuring the function against the looks preface. In measuring parameter register 0x2C, bit3 , bit4 provide the state sign that the voltage goes against the looks preface against the looks preface and electric current.

Lose and press and measure :

ATT7022B have one broken looks threshold value register, as is it get voltage value , virtual value of register lower than disconnected looks value , threshold value of register to measure, bit0 ,bit1 , bit2 in measuring parameter register 0x2C provide A , B , C every phase and lose and press the state sign .

Frequency:

By crossing the zero point of voltage signal, ATT7022B measures the frequency of the base wave of the electric wire netting, leaves in order to mend counting in the register, because frequency value can not for shoulder, so high position can not 1 the most. Read register value divided by 2 ^ 13, it is the

版权归钜泉光电科技（上海）有限公司所有

frequency value, this parameter does not need correcting .

Electric energy:

ATT7022B offers various kinds of electric energy record materials: The whole wave is to the meritorious electric energy record, meritorious electric energy record backward of the whole wave, wave not the whole writing down with work the electric energies, wave not the whole to having (wave not in harmony) for work the electric energies write down, electric energy not meritorious write down, base wave (wave not in harmony) have work electricity of base wave (wave not in harmony) for work t backward, RMS apparent electric energy and apparent electric energy of PQS. Each record will offer corresponding electric energy register and electric energy register of zero clearing after reading of zero clearing after reading (mark 2 register). The renewal that the electric energy record is in pace with form pulse of the school, namely CF mouth generates a electric energy pulse, corresponding electric energy register number value adds one. So value, energy of register, divided by pulse constant, actual power consuming reading. It is meritorious electric energy register (whether reach 0x21 of 0x1E, reach 0x34 of 0x31) it write down to and wave absolute value of electric energy not meritorious not the whole backward and, work it have electric energy register (reach 0x25 of 0x22 , reach 0x38 of 0x35) write down to and backward wave not the whole absolute value, work of electric energy and. It write down base wave or wave or RMS not in harmony of electric energy register (reach 0x53 of 0x50 , reach 0x73 of 0x70) to and absolute value of electric energy not meritorious backward and, it work base wave not same by electric energy register (reach 0x57 of 0x54 , reach 0x77 of 0x74) it write down base wave or wave or PQS not in harmony of to and can't absolute value , work of electric energy backward and. Shut the looks electric energy (Register 0x21, 0x25, 0x34, 0x38, the value of 0x43 , 0x47 , 0x4B , 0x4F , 0x53 , 0x57 , 0x63 , 0x67 , 0x6B , 0x6F , 0x73 , 0x77) is to accumulate the way according to the energy established , the calculation carrying on absolute value sueing for peace or algebra of the three-phase electric energy and sueing for peace is got. Fetch absolute value sue for peace way accumulate three-phase electric energy , shut reverse electric energy of looks it worthes to be always zero. Every phase and shutting the looks electric energy register (the register of marking 2) after reading of zero clearing since reading, a corresponding one its mark 2 register can when the new pulse comes zero clearing too. When the chip is fixed again, the register quilt zero clearing of electric energy.

Temperature:

ATT7022B built-in temperature-sensitive sticker, offer one ADC of 8 sample to export to temperature, analyze degree it about 1 degrees Centigrade. Low 8 of the register are effective, should be worth needing to correct, true temperature value is TC-TM, TC, for the correcting value, TM is read the data by register, the value after calculating should be changed into original yard, if the high position fetches and adds 1 instead for one. The temperature-sensitive sticker needs to pass register GCtrlT7Adc (Addr: 0x2C) make and can be controlled, only when Bit of GCtrlT7Adc 2/1=10 is opened, Bit 2/1=00/01/11Shut off the temperature-sensitive sticker hour.

Measurement condition choice

ATT7022B may establish five kind of measurement conditions: Full wave measurement condition, RMS apparent electrical energy measurement condition, PQS apparent measurement condition, fundamental wave measurement condition, overtone measurement condition.When ATT7022B work the full wave measurement is the basic function, but other four conditions only can choose one kind or all not choose.Its choice method please

版权归钜泉光电科技（上海）有限公司所有

refer to following form:

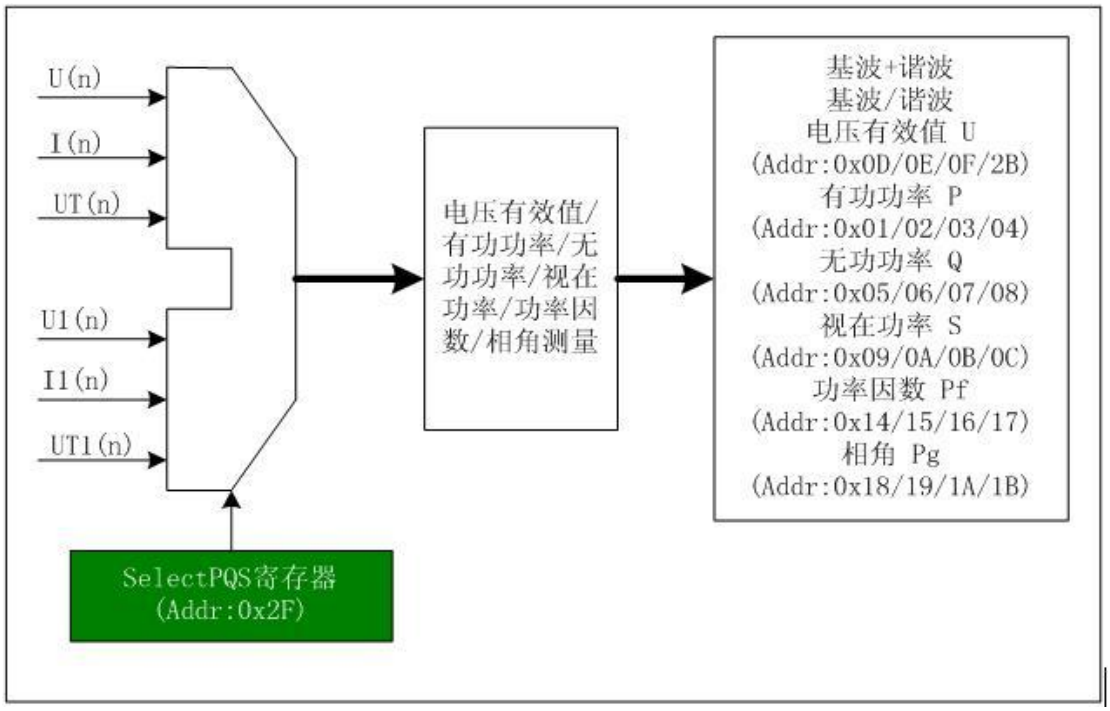
EnLineFreq Content of the register	EnHarmonic Content of the register	function
0x007812	Not equal to 0x0055AA	Fundamental wave meter
	0x0055AA	Harmonic meter
0x008127	------	RMS apparent energy meter
0x005523	------	PQS apparent energy meter
Other value	------	Forbid above function

Notice that will fill in materials 0x007812 in EnLineFreq register first while choosing the wave form way in harmony , then fill in materials 0x0055AA to EnHarmonic register , make the chip in the wave in harmony and measure the state, if the materials that EnHarmonic register fills in are not 0x0055AA, then the chip is in the base wave and measure the state.

It is a basic function that the whole wave of ATT7022B measures the state, it is effective all the time that the electric energy pulse exports CF1 , CF2, it was big or small that its frequency reflected and shut looks gaining merit equally and inactive power in the whole unexpected turn of , the check-up of gaining merit dailily in the instrument and inactive power, can be used as the whole wave and gains merit and has no electric energy measurement of work . When open RMS apparent state of measuring of electric energy, RMS apparent electric energy pulse is exported by CF3, CF4 is invalid; While opening PQS apparent state of measuring of electric energy, PQS apparent electric energy pulse is exported by CF4, CF3 is invalid; While opening the state of measuring of electric energy of unexpected turn of of base, CF3, CF4 effective, its electric energy pulse output frequency reflect base wave shut looks gain merit and size of inactive power equally, can be used in the check-up of instrument base wave gaining merit and inactive power , can be used as the base wave and gains merit and has no electric energy measurement of work ; While opening the state of measuring of electric energy of wave in harmony, CF3, CF4 effective, its electric energy pulse output frequency reflect to shut looks gain merit and size of inactive power equally in harmony wave, can be used in the check-up of instrument wave gaining merit and inactive power in harmony , can be used as the wave in harmony and gains merit and has no electric energy measurement of work .

ATT7022B offers the whole wave power, voltage, frequency, voltage contained angle, power factor, photo corner of states,etc. to measure the parameter, whether when ATT7022B opens the base wave or the state of measuring of wave in harmony , register these choose register SelectPQSU through parameter (Addr. 0x3C), can also offer the parameters , such as corresponding base wave or power of wave , voltage , power factor and photo corner in harmony ,etc. , its block diagram is as follows:

版权归钜泉光电科技（上海）有限公司所有



From on pursue it can be seen,control register the SelectPQSUs participate in voltage the virtual values , power , power factor , signal source , photo corner of operation, SelectPQSU ╳ 0x001228 hour, by U (n) , I (n), the whole wave sampling signal of UT (n) make operation, receives parameters , such as voltage virtual value , power , power factor , photo corner of the whole wave ,etc., act as SelectPQSU =0x001228 hour, by U1 (n), I1 (n), UT1 (n) these base wave or in harmony wave sampling signal is it make operation to go on (confirm to be base wave signal or in harmony wave signal by EnLineFreq and EnHarmonic register), get the parameters , such as the base wave or the voltage virtual value , power , power factor , photo corner of the wave in harmony ,etc. correspondingly . When EnLineFreq has not chosen the base wave or the wave form in harmony , the choice of SelectPQSU works.

When ATT7022B is in the base wave or the state of measuring of wave in harmony , voltage contained angle , the looks preface of the electric current , these two functions try one's best to close at ordinary times , don't open at the same time , so as not to influence the precision.

The meter calibration referance:

The meter calibration form is gained to every phase electric current, voltage gaining , power gaining , phase place is compensated , the power gains and compensates and proposes not segmenting. Phase place is it can require according to precision , is it segment or go on by stage to consider to correct. It segments to be to is it divide to come according to size of electric current , correct to phase place , can divide 5 go on at most. Starting electric current and giving up the voltage of threshold value of the looks and can be set up with the software of ATT7022B. When ATT7022B runs the form of software school, generally speaking the voltage , electric current are corrected, start the electric current to set up , give up the voltage of threshold value of the looks to set up , there is not a request on a order . While carrying on the power to gain and correct, please notice and set up and shut first that looks energy accumulate the way (needed to save this step by you such as the defaulting value) , voltage passway ADC gain and output the parameter with high frequency, this is the condition that power corrects,

版权归钜泉光电科技（上海）有限公司所有

and then do the power to gain and correct first , and then correct the phase place, the phase place is corrected to finish the power and carry on after being being gained and corrected. Correcting carrying on for the terms of zero in the corresponding register parameter of the form of school of all. ATT7022B is being set up into a wave form of the base , the wave form in harmony or looking at when the electric energy measures the function, set up and help the wave form state to correct first while proposing the school form , has already enabled controlling the wave measurement of the base register EnLineFreq =0x000000, is it fill out register this according to need corresponding value make chip enter base wave form well to correct, the wave form or apparent electric energy in harmony measure the function state , does not need to do the base wave , wave form or apparent electric energy in harmony and measure error correction after generally correcting, w _ What the defaulting value offered gains and can guarantee enough precision while correcting coefficient in LineFreqPg (0x31) register.

Set up voltage passway ADC and gain UADCPga

Voltage passway ADC gains UADCPga (0x3F) and sets up voltage passway ADC and amplifies the multiple through filling in, propose that the sample signal Vu * while guaranteeing specified Un of voltage amplifies multiple UADCPgain and equals about 0.5V.

Set up high frequency and output parameter HFreq

This is about the output dial gauge pulse frequency frequency division coefficient.

$$INT\left[5760000000\times\frac{G\times G\times V_u\times V_i}{U_n\times I_b\times N}\right]$$

Hfreq=

In the type: Un, in order to join than the voltage, Ib is the specified electric current, N is a pulse constant, Vu is being joined and inputting more than the voltage, it is at chip sample voltage it in charge of foot (V2p and V2n, V4p and V4n , V6p and V6n,) corresponding voltage (if gain after setting up voltage the passways, it should be the voltage after amplifying), sample not in charge of foot ofing when it is in Vi input electric current not specified chip electric current (V1p and V1n, V3p and V3n, V5p and V5n,) corresponding voltage, G is the constant 0.648, Hfreq outputs the constant for high frequency. Write Hfreq value into school form register 20H, the chip sends out CF signal according to the pulse constant designed. Notice that this parameter fetching value should not be smaller than 0x000004 , should not at the same time be greater than 0x000D00.

Set up than the compensation area of difference

Parameter that the voltage of electric current according to recommending above samples, ATT7022B is 1000: The linear range of 1, the power gains and corrects needing to segment , can simplify the school form course of production , do not need to set up more than the regional register (0x1E) of difference compensation at this moment, keep for zero (namely the preserving value while restoring to the throne).

Set up the phase place and compensate the area

The error of the phase place is asymmetric by the parameter of the circuit with samples of angle difference of the mutual inductor mainly, it is caused, usually can meet 1 , 0.5 grades of requests of electric energy meter if not needing to segment that the signal leaves in the line inconsistently etc., namely pay the area for the phase place sets up register 0x02, value of 0x03 , 0x04 , 0x05 to keep as zero. To the high-accuracy electric energy meter , such as 0.5S or 0.2S , need to do the precision of phase place by stage and correcting, it is set up according to the size of the electric current that it segments, 4 begins to set up to pay the area for setting up from the phase place, the electric current segments minimumly some writes into the phase place and pays the area for and sets up 4, greatest some of segmentation of electric current writes into the phase place and pays the area for and sets up 1. If

版权归钜泉光电科技（上海）有限公司所有

click fewer than 4 by stage , should compensate the area from the phase place and set up 4 and begin to set up sequentially , other some parameters of establishment keep as zero. For example pay the area for the phase place divide into two sections and go on, click and have locating in 15% of the Ib by stage, namely Is4 =15%Vi =0.15*0.1 =0.015V, Iregion4 =INT(G*Is4*2 ^ 23)=0x013E81, so long as write 0x013E81 into the phase place to compensate the area to set up 4 (address 0x05) of, it is zero that pay other phase places for the number value of setting up register in the area.

The power gaining and correcting

The power gains and corrects carrying on for the condition of 1 in the power factor. Propose electric current is it correct to order in Ib , gain power 0 gain with power 1 register value write with the same correcting value.

Correct the formula： $Pgain=\frac{-err}{1+err}$

If Pgain≥0，Pgain=INT（Pgain*2^23）

Pgain <0，Pgain=INT（2^24+Pgain*2^23）

It is a error not including %'s symbol to pay attention to calculating electric energy error err in formulae.

The phase place correcting

It is carried on for the condition of 0.5L in the power factor that the phase place is corrected. Pay the area for and choose suitable correcting the electric current clicked according to the phase place set up , can receive the satisfactory precision of power to make. If does not segment , propose correcting to the phase place of area 4 register value in area 0 to write with the same correcting value.

Correct the formula： $\theta=\arccos((1+err)*0.5)-\pi/3$

If θ ≥0，Phsreg=INT（θ*2^23）

θ <0，Phsreg =INT（2^24+θ*2^23）

The phase place is corrected to calculate the unit as the radian in the formula.

Base wave / the wave (apparent electric energy) in harmony correcting

Correct and all use the power of unexpected turn of of the base to correct register LineFreqPg in base wave , unexpected turn of and apparent electric energy of RMS , PQS apparent electric energy volume in harmony of TT7022B (Addr: 0x31), in power factor cos (¦μ) =Carry on base wave power is it correct to gain one o'clock, phase any will do.

Correct the formula：

$LineFreqPg=\frac{-err}{1+err}$

If LineFreqPg >=0，therefore LineFreqPg =INT[LineFreqPg *2^{23}]

Otherwise LineFreqPg <0，則LineFreqPg =INT[2^{24}+ LineFreqPg *2^{23}]

The defaulting value of LineFreqPg register is 0x0020C4, generally speaking it need it is in addition it is for base wave /whether wave (electric energy not apparent) not in harmony correct,can meet with defaulting value of it by precision request, should pay attention to power go on zero clearing operate it LineFreqPg register first before correcting in base wave / in harmony wave (apparent electric energy) too at the same time.

Set up the pulse constant and enlarge one time of rates

In the small electric current in the real school form course inputs cases, because of causing school form time very slowly long of electric energy pulse, ATT7022B offers the pulse constant to enlarge one time of rates register

版权归钜泉光电科技（上海）有限公司所有

HFDouble, through filling in different value of HFDouble register content, improve light school form speed of electric current power amplification 2 - 4 - 8 - 16. In order to prevent the number value caused of power amplification from overflowing, this function is generally used in the test of the electric current under 5% of the Ib. Notice the pulse constant enlarging time and leading the form at school to change to go back as 1 after finishing, so as not to cause the mistake of measuring.

Voltage channel ADC gain choice

In order to reduce between the channel the crosstalk as well as increases the voltage sampling channel input voltage the scope and the flexibility, ATT7022B provides voltage channel ADC gain choice register UADCPga, uses in controlling the voltage channel the ADC enlargement factor, some 1, 2, 4, 8, 16 and so on enlargement factor choices, but must pay attention when fills in this control register material 0xA5xxxx is the prohibition reads in.The suggestion in senate voltage gradient Un time sample signal Vu is 0.1V, enlargement factor UADCPgain=4, like this may obtain the good straight characteristic, the guarantee measuring accuracy.

Set up and start the electric current

The preserving value starting the electric current register after being restored to the throne is 0x280, when the corresponding arrival electric current, for 0.1% of the Ib (Ib to input, introduction is 0.1V to sample), namely when the value of reading electric current register not making electric current before correcting is greater than or equal 0x280, the ammeter is in the state of starting, can output the electric energy pulse , on the contrary, when the value of reading electric current register is smaller than 0x280, the ammeter is in sneaking the state of moving , do not output the electric energy pulse . Whether power is it is it when segmenting , start establishment of electric current can according to following to calculate formula to make to gain.

Istartup=INT（G*Io*2^23）

In the type: G is 0.648, Io is the voltage of sample of the chip port while starting the electric current and is input, for example start the electric current as 0.4% of the Ib, the voltage that Ib samples while inputting is as 0.1V, then Io =0.1*0.4/100 =0.0004V. When the power is gained and corrected by stage , the settlement value which starts the electric current is Istartup =INT(0.8*G*Io*2 ^ 23),Namely is multiplied by coefficient 0.8 on the calculating value originally. Size of the voltage that the establishment and Ib of starting the electric current sample while inputting , relating to the fact that input the non-linear degree under the small electric current of circuit, users can adjust the arrival electric current value established according to one's own design .

Voltage Adjustment

It is independent for power gaining and phase place to correct that the voltage is corrected, the voltage correcting value will sample as a coefficient of varying the voltage will be varied for standard voltage value. On terms that open the voltage of wave in harmony to test, in order to improve the resolution of the voltage signal, propose correcting the voltage to above 400V in ATT7022B, deal with from one-chip computer into a real voltage signal finally. When Un is input for 220V, it makes ATT7022B export 440V to correct through the voltage , will examine the signal had divided by 2 in the one-chip computer, get the last measurement value 220V. If Un is 100V corrected to 400V, will be examined the signal had divided by 4 by the one-chip computer while importing, get the last measurement value 100V. If Un is 57.7V corrected to 461.6V, will be examined the signal had divided by 8 by the one-chip computer while importing, get the last measurement value 57.7V.

The electric current correcting

It is similar to correct with the voltage, it is independent for power gaining and phase place to correct that the electric current is corrected, the correcting value of electric current will sample as a coefficient of varying the voltage will be varied for standard electric current value. The voltage is 0.1V in the specified electric current that the electric current passway samples, the value of the when have not corrected electric current virtual value register corresponding invites about 60A, in case of needing to use and shut electric current value of the looks, in

版权归钜泉光电科技（上海）有限公司所有

order to guarantee to shut the calculation accuracy of the looks electric current, every phase electric current value after correcting should guarantee certain resolution . Is it import to electric current for correct the electric current the value close to 60A among ATT7022B at the specified electric current to propose. Consider the convenience of calculating, can correct the electric current to Ib X 2 close to 60A ^ N, deals with from one-chip computer into a real electric current signal finally. When Ib is input for 1.5A, it makes ATT7022B export 96A to correct through the electric current , will examine the signal had divided by 64 in the one-chip computer, get the last measurement value 1.5A. If Ib is 5A corrected to 80A, will be examined the signal had divided by 16 by the one-chip computer while importing, get the last measurement value 5A. If Ib is 20A corrected to 80A, will be examined the signal had divided by 4 by the one-chip computer while importing, get the last measurement value 20A.

The establishment breaks the threshold value

Give up the establishment of the threshold value of the looks after the voltage is corrected and finished.

Ⅳ Software dial gauge formula demonstration

The software dial gauge flow is as follows: (When writes operation, the dial gauge register position site highest position 1, called it is order, if writes register 20H, order is 0A0H)

⑴Reset ATT7022B, examines SIG is low when delivers the dial gauge material, this step may abbreviate.

⑵Filling in voltage channel ADC gain UADCPga(0x3F) establishment voltage channel ADC enlargement factor.

⑶Writes the high frequency pulse output parameter (to order 0A0H) to dial gauge register 20H.

⑷Writes the starting current (to order 9FH) to dial gauge register 1FH, if does not do this step, default start magnitude of current for basic electric current 0.1%.

⑸Writes breaks the threshold value voltage (to order 0A9H) to dial gauge register 29H, if does not do this step, the default breaks the threshold value voltage 10% for the senate voltage gradient (speaking of three-phase four) or 60% (speaking of three-phase three).

⑹Writes the phase compensation region to establish to dial gauge register 02H, 03H, 04H, 05H (orders 82H, 83H, 84H, 85H), if does not do this step, expressed does not partition carries on the phase calibration, this time the phase correct value default takes the region 0 phases to adjust the register the value. If wrote the phase compensation region establishment register (partition to carry on establishment according to electric current size, established 4 from phase compensation region to start to establish, electric current smallest partition spot read in phase compensation region to establish 4), then was lower than the phase compensation region to establish 4 partition electric current the phase correct value to read in the region 4 phase adjustment register; Is lower than the phase compensation region to establish 3 partition electric current the phase correct value to read in the region 3 phase adjustment register; Analogizes in turn, finally is higher than the phase compensation region to establish 1 partition electric current the phase correct value to read in the region 0 phase adjustment register.If phase partition insufficient 5 sections, then establishes 4 from the phase compensation region to start to establish, the insufficient register establishment value is a zero.

⑺The electric instrument in the input three-phase voltage, respectively gives A, B, C inputs the basic electric current, the power factor is under 1 condition, according to each electrical energy error value which obtains, writes the power gain value to arrive corresponding dial gauge register 06H, 07H, 08H (orders 86H, 87H, 88H) and in 09H, 0AH, 0BH (orders 89H, 8AH, 8BH).

⑻The electric instrument in the input three-phase voltage, respectively gives A, B, C inputs the basic electric current, the power factor is under the 0.5L condition, according to each electrical energy error value which

版权归钜泉光电科技（上海）有限公司所有

obtains, writes the phase correct value to arrive dial gauge register 0CH, 11H, 16H.If does not partition makes the phase calibration, then simultaneously writes about the phase correct value in dial gauge register 0DH, 0EH, 0FH, 10H, 12H, 13H, 14H, 15H, 17H, 18H, 19H, 1AH.If partitions makes the phase calibration, then the electric instrument in the input three-phase voltage, according to the phase compensation region division, gives A, B, C separately inputs compensates the region center point the electric current (i.e. check point far away partition spot, avoids error beating), the power factor is under the 0.5L condition, according to each electrical energy error value which obtains, writes the phase correct value to dial gauge register 10H, 15H, 1AH and so on.

⑼The input reference voltage, according to the voltage demonstration value, writes the correct value separately to in dial gauge register 1BH, 1CH, 1DH.

⑽Inputs the basic electric current, according to the electric current demonstration value, writes the correct value separately to in dial gauge register 26H, 27H, 28H.

⑾The filling in fundamental wave survey enables control register EnLineFreq, causes measurement active status which ATT7022B is in needs.

⑿If must choose the harmonic measurement active status, enables control register EnLineFreq=0x007812 in the filling in fundamental wave survey, after causes ATT7022B to be at the fundamental wave measurement active status, then fills in the fundamental wave survey and the overtone survey cuts choice register EnHarmonic=0x0055AA, causes ATT7022B to be at the overtone measurement active status, if fills in other values then ATT7022B is at the fundamental wave measurement active status, if does not choose the overtone measurement condition, then this step jump. Attention: * The dial gauge is carries on in the corresponding dial gauge register content for under the zero condition.

Software dial gauge application example: .

Take the 1.5(6)A,220V three-phase four tables as the example, the design variable is as follows:

Pulse constant N is 3200imp/kWh, when nominal current input, when the electric current channel input voltage Vi is 0.1V, the reference voltage input, voltage channel input voltage Vu is 0.1V, establishes this table the overtone measurement condition.

The following program wrote with 8051 assembly languages, entrance: The A register is the command (regarding to write operation) or the address (regarding reads operation), 20H, 21H, 22H are write register, 30H, 31H, 32H are read register, R0 register save first address of write or read date, the R3 register is the byte number which writes or reads. WR_SPI is writes ATT7022B the vice- program, RE_SPI is reads ATT7022B the vice-program.

```
(1)Reset ATT7022B

RESET7022B:
        CLR  ATT7022B_RST
        MOV R7,#20H              ;delay
DELAY1: NOP
        DJNZ R7,DELAY1
        SETB  ATT7022B_RST
        MOV R7,#0FFH             ;delay

DELAY2: NOP
        DJNZ R7,DELAY2
```

版权归钜泉光电科技（上海）有限公司所有

```
RET
```

(2)Filling in voltage channel ADC gian UADCPga(0x3F) establishment voltage channel ADC enlargement factor is 4:

```
MOV 20H，#46H
MOV 21H，#55H
MOV 22H，#01H
MOV A，#0BFH
LCALL WR_SPI
```

(3)Write HFConst:

Hfreq=

$$INT\left[5760000000\times\frac{G\times G\times V_u\times V_i}{U_n\times I_b\times N}\right]$$

=5760000000*0.648*0.648*0.5*0.1/(220*1.5*3200)

=114=72H

```
MOV 20H，#00H
MOV 21H，#00H
MOV 22H，#72H
MOV A，#0A0H
LCALL WR_SPI
```

(4)Wirte Inruch current：

Io=0.4%*Vi=0.004*0.1=0.0004

Istartup=G* Io=0.648*0.0004=0.0002592

Istartup=0.0002592*2^23=2174=87EH

```
MOV 20H，#00H
MOV 21H，#08H
MOV 22H，#7EH
MOV A，#9FH
LCALL WR_SPI
```

(5)Writes the A power gain:

The three-phase voltage inputs 220 volts, inputs the A interphase current 1.5 A, the power factor is 1.0, standard table electrical energy error reading for - 0.74%, namely err=-0.0074, then:

Pgain=$\frac{-err}{1+err}$=0.0074/(1-0.0074)=0.00745516

Pgain= Pgain*2^23=0.00745516*2^23=62538=0F44AH

版权归钜泉光电科技（上海）有限公司所有

```
    MOV 20H，#00H
    MOV 21H，#0F4H
    MOV 22H，#4AH
    MOV A，#86H
    LCALL WR_SPI
    MOV A，#89H                    ；Does not partition, writes each section register the
similar correct value
    LCALL WR_SPI
```

(6)Writes the A phase adjustment:

The three-phase voltage inputs 220 volts, inputs the A interphase current 1.5 A, the power factor is 0.5L, the standard table electrical energy error reading is 1.74%, err=0.0174,

then: θ=acos((1+err)*0.5)-π/3

=acos((1+0.0174)*0.5)-π/3

= acos(0.5087) -π/3= -0.01007537<0

Phsreg=2^24+θ*2^23=16692697=FEB5D9H

```
    MOV 20H，#0FEH
    MOV 21H，#0B5H
    MOV 22H，#0D9H
    MOV A，#8CH
    LCALL WR_SPI
    MOV A，#8DH                    ；Does not partition, writes each section register the
similar correct value

    LCALL WR_SPI
    MOV A，#8EH
    LCALL WR_SPI
    MOV A，#8FH
    LCALL WR_SPI
    MOV A，#90H
    LCALL WR_SPI
```

(7)Writes the B power gain:

The three-phase voltage inputs 220 volts, inputs the B interphase current 1.5 A, the power factor is 1.0, the standard table electrical energy error, the standard table electrical energy error reading is 1.26%, err=0.0126, then:

Pgain=$\frac{-err}{1+err}$= -0.0126/(1+0.0126)= -0.01244322<0

版权归钜泉光电科技（上海）有限公司所有

Pgain=2^24+Pgain*2^23

=2^24 - 0.01244322*2^23=16672834=FE6842H

```
MOV 20H，#0FEH
MOV 21H，#68H
MOV 22H，#42H
MOV A，#87H
LCALL WR_SPI
MOV A，#8AH                    ；Does not partition, writes each section register the
similar correct value
LCALL WR_SPI
```

(8)Writes the B phase adjustment

The three-phase voltage inputs 220 volts, inputs the B interphase current 1.5 A, the power factor is 0.5L, the standard table electrical energy error reading is - 1.74%, err=-0.0174, then:

θ=acos((1+err)*0.5)-π/3

=acos((1-0.0174)*0.5)-π/3

= acos(0.4913) -π/3= 0.01001709>0

Phsreg=θ*2^23=84029=1483DH

```
MOV 20H，#01H
MOV 21H，#48H
MOV 22H，#3DH
MOV A，#91H
LCALL WR_SPI
MOV A，#92H                    ；Does not partition, writes each section register the
similar correct value

LCALL WR_SPI
MOV A，#93H
LCALL WR_SPI
MOV A，#94H
LCALL WR_SPI
MOV A，#95H
LCALL WR_SPI
```

(9)Writes the C power gain

The three-phase voltage inputs 220 volts, inputs the C interphase current 1.5 A, the power factor isy 1.0, the standard table obtains the electrical energy error is 0.5%, ERR=0.005, then:

版权归钜泉光电科技（上海）有限公司所有

Pgain=$\frac{-err}{1+err}$= -0.005/(1+0.005)= -0.00497512<0

Pgain=2^24+Pgain*2^23==2^24 - 0.00497512*2^23=16735481=FF5CF9H

```
MOV 20H，#0FFH
MOV 21H，#5CH
MOV 22H，#0F9H
MOV A，#88H
LCALL WR_SPI
MOV A，#8BH                ；Does not partition, writes each section register the
similar correct value
LCALL WR_SPI
```

⑽寫 C phase adjustment

The three-phase voltage inputs 220 volts, inputs the C interphase current 1.5 A, the power factor is 1.0, the standard table obtains the electrical energy error is 0.5%, ERR=0.005, then:

θ=acos((1+err)*0.5)-π/3

=acos((1-0.0174)*0.5)-π/3

=acos(0.4913) -π/3= 0.01001709>0

Phsreg=θ*2^23=84029=1483DH

```
MOV 20H，#01H
MOV 21H，#48H
MOV 22H，#3DH
MOV A，#96H
LCALL WR_SPI
MOV A，#97H                ；Does not partition, writes each section register the
similar correct value
LCALL WR_SPI
MOV A，#98H
LCALL WR_SPI
MOV A，#99H
LCALL WR_SPI
MOV A，#9AH
LCALL WR_SPI
```

⑾Writes A, B, the C phase voltage adjustment:

The three-phase voltage inputs 220 volts, the three-phase current inputs 1.5 A, the power factor is 1.0, voltage register value Vu respectively is 0x2A8000=2785280, 0x2AE305=2810629, 0x2B00F1=2818289, after effective value

版权归钜泉光电科技（上海）有限公司所有

computation:

Urms=Vu*2^10/2^23=Vu/2^13

In the electrical energy table voltage reading respectively is 340V, 343.09V, 344.03V, the voltage correct value is:

Ugain=Ur/Urms -1

Ur is the standard table voltage reading. Because of opening harmonic voltage test function, When adjustment the Ur value substitutes the computation with 2 times of standard table voltage values. After adjustment finished, when survey, MCU should the voltage effective value which reads out do divides 2 operations, namely Urms=Vu*/2^13/2=Vu/2^14

A Phase voltage correct valueUgain =440/340-1=0.2941176>0

Ugain=INT(Ugain*2^23)=0x25A5A5

```
MOV 20H，#25H
MOV 21H，#0A5H
MOV 22H，#0A5H
MOV A，#9BH
LCALL WR_SPI
```

B Phase voltage correct valueUgain=440/343.09-1=0.278958>0

Ugain=INT(Ugain*2^23)=0x23B4E7

```
MOV 20H，#23H
MOV 21H，#0B4H
MOV 22H，#0E7H
MOV A，#9CH
LCALL WR_SPI
```

C Phase voltage correct valueUgain= 440/344.03-1=0.278958>0

Ugain=INT(Ugain*2^23)=0x23B4E7

```
MOV 20H，#23H
MOV 21H，#0B4H
MOV 22H，#0E7H
MOV A，#9DH
LCALL WR_SPI
```

⑿Writes A, B, the C interphase current adjustment:

The three-phase voltage inputs 220 volts, the three-phase current inputs 1.5 A, the power factor is 1.0, reads the electric current register the value Ii respectively is 0x7C000=507904, 0x75CCC=482508, 0x78000=491520, after effective value computation:Irms=Ii*2^10/2^23=Ii/2^13

In the electrical energy table voltage reading respectively is 62A, 58.9A, 60A, the electric current correct value is

Igain=Ir/Irms -1

If does not need to read gathers the interphase current value, when adjustment Ir may use directly the value substitutes the computation with standard table magnitude of current 1.5A. If needs to read gathers the interphase current value, when dial gauge Ir with the 2^6

版权归钜泉光电科技（上海）有限公司所有

time of standard table magnitude of current substitution computation, namely Ir=1.5*2^6=96, after the dial gauge completes, when survey, MCU should the electric current effective value which reads out do divides 2^6 the operation, namely Urms=Vi*/2^13/2^6=Vi/2^19

AInterphase current correct valueIgain=96/62-1=0.548387>0

Igain=INT(Igain*2^23)=0x46318C

```
MOV 20H，#46H
MOV 21H，#31H
MOV 22H，#8CH
MOV A，#0A6H
LCALL WR_SPI
```

B. Interphase current correct valueIgain=96/58.9-1=0.629881

Igain=INT(Igain*2^23)=0x509FF2

```
MOV 20H，#50H
MOV 21H，#9FH
MOV 22H，#0F2H
MOV A，#0A7H
LCALL WR_SPI
```

C. Interphase current correct valueIgain=96/60-1=0.6

Igain=INT(Igain*2^23)=0x4CCCCC

```
MOV 20H，#4CH
MOV 21H，#0CCH
MOV 22H，#0CCH
MOV A，#0A8H
LCALL WR_SPI
```

⑬The filling in fundamental wave survey enables control register EnLineFreq, causes ATT7022B to be at the fundamental wave measurement active status.

```
MOV 20H，#00H
MOV 21H，#78H
MOV 22H，#12H
MOV A，#0ADH
LCALL WR_SPI
```

⑭The filling in fundamental wave survey and the overtone survey changes to choice register EnHarmonic, causes ATT7022B to be at the overtone measurement active status.

```
MOV 20H，#00H
MOV 21H，#55H
MOV 22H，#0AAH
MOV A，#0BCH
LCALL WR_SPI
```

Vice-program：

版权归钜泉光电科技（上海）有限公司所有

```
    WR_SPI:
            MOV R0，#20H
            MOV R3，#03H
            SETB SPI_CS
            CLR SPI_CK
            CLR SPI_CS
            ACALL OTB
    WR_SPI1:MOV A,@R0
            INC R0
            ACALL OTB
            DJNZ R3,WR_SPI1
            SETB SPI_CS
            RET
```

Read register operation:

Input：A register is address of read counter parameter register

Output：R0 means to use the serial three register to save date of read counter parameter register

```
            MOV A,#04H
            LCALL RE_SPI

    RE_SPI: MOV R3,#03H
            MOV R0,#30H
            SETB SPI_CS
            CLR SPI_CK
            CLR SPI_CS
            ACALL OTB
            SETB SPI_DO
    RE_SPI1:MOV A,#00H
            ACALL INB
            MOV @R0,A
            INC R0
            DJNZ R3,RE_SPI1
            SETB SPI_CS
            RET

    OTB:    MOV R2，#08H
    OTB1:   SETB SPI_CK
            RLC A
            MOV SPI_DI,C
            NOP
            NOP
            NOP
            CLR SPI_CK
            DJNZ R2，OTB1
            RET
```

版权归钜泉光电科技（上海）有限公司所有

```
INB:    MOV R2，#08H
INB1:   SETB SPI_CK
        NOP
        NOP
        NOP
        MOV C，SPI_DO
        RLC A
        CLR SPI_CK
        DJNZ R2，INB1
        RET
```

版权归钜泉光电科技（上海）有限公司所有